NASA Innovative Advanced Concepts

The Regolith Biters: A Divide-And-Conquer Architecture for Sample Return Missions

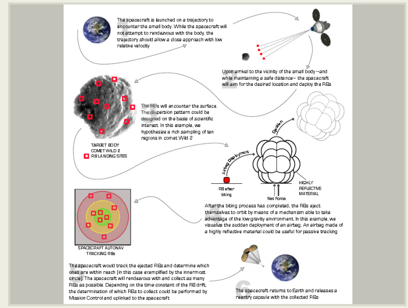
Completed Technology Project (2012 - 2013)

Project Introduction

Asteroid Sample Return mission architecture study, with a flyby motership releasing small sample takers, called Regolith Biters (RBs). After flyby, the RBs would rendezvous with the mothership to return to Earth. A spacecraft carrying a number of Regolith Biters (RBs) would travel to the vicinity of a small body. From a favorable vantage point, and while remaining within a safe distance in a non-colliding trajectory, it would release the RBs towards the target body. Upon encountering the body, they would bite the regolith (thus retaining a sample), and eject back to orbit. The spacecraft, being endowed with appropriate navigation and tracking capabilities, would rendezvous with and collect those RBs within its reach, and bring them back to Earth. Separating the navigation and sampling concerns removes the need for proximity operations with the small body--the stage in current architectures that carries the most challenges and risks. Eliminating the need for proximity operations brings back to the discussion the exploration of exciting prospects, like highly active comets, fast-rotating bodies, and binary systems. Distributing the sampling problem among a collective of agents provides the opportunity to sample multiple regions in a single mission. It also provides robustness to various environmental conditions, and may enable the distributed, in situ characterization of the body. In the search for reliability, current architectures rely on complexity: an elaborate system should succeed at once. We rely on numbers: a given agent may fail at any stage, but success is attained by the collective.

Anticipated Benefits

This concept is fundamentally different from existing alternatives because it is based on the premise that separating the navigation problem from the sample collection problem will lead to a more robust and exible overall system.



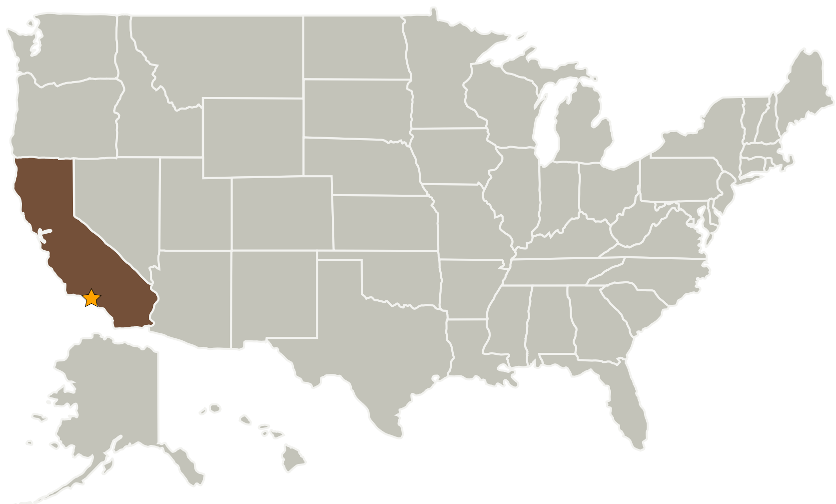
Project Image The Regolith Biters: A Divide-And-Conquer Architecture for Sample Return Missions

Table of Contents

The Regolith Biters: A Divide-And-Conquer Architecture for Sample Return Missions

Completed Technology Project (2012 - 2013)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Transitions

September 2012: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

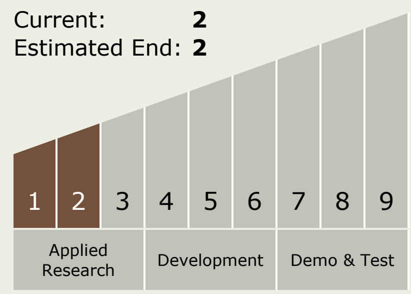
Eric A Eberly

Principal Investigator:

Juan Arrieta

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



The Regolith Biters: A Divide-And-Conquer Architecture for Sample Return Missions

Completed Technology Project (2012 - 2013)

June 2013: Closed out

Closeout Summary: The concept investigated consists of a space mission archi tecture for collecting multiple, distributed samples from small, primitive celestial bodies (like asteroids and comets) and bringing them back to Earth for their stu dy; It is fundamentally different from existing alternatives because it is based o n the premise that separating the navigation problem from the sample collection problem will lead to a more robust and flexible overall system. The current archi tectural paradigm for sample-return missions is centered around a design where spacecraft and sampling device are merged into a single, complex system; we a rgue that this monolithic approach couples the navigation and sample-collection problems, making both more difficult. We diverge from this vision, and propose a decoupled system-based on the coordinated interaction between a spacecraft and a collective of small, simple devices, which we have called the Regolith Biter s(RBs). A spacecraft carrying a number of RBs would travel to the vicinity of a s mall body. From a favorable vantage point, and while remaining at a safe distan ce on a non-colliding trajectory, it would release an approach stage capable of d elivering the RBs towards the target body. Upon encountering the body, the RBs would bite the regolith (thus retaining a sample), and eject back to a heliocentri c orbit. The spacecraft, being endowed with appropriate propulsion, navigation a nd tracking capabilities, would rendezvous with and collect those RBs within its r each, and bring them back to Earth. Separating the navigation and sampling con cerns could remove the need for proximity operations with the small body---the stage in current architectures that carries the most challenges and risks. Elimina ting the need for small body proximity operations brings back to the discussion t he exploration of exciting prospects like highly active comets, fast-rotating bodie s, and binary systems. In addition, distributing the sampling problem among a c ollective of agents could provide the opportunity to sample multiple regions ---o n one or multiple bodies within a system - in a single mission. It may also provid e robustness to various environmental conditions, and enable the distributed, in -situ characterization of the small body. These technical distinctions separate ou r concept from existing art.

Technology Areas

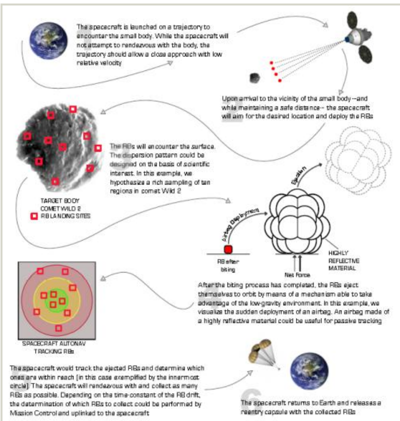
Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - └ TX17.2 Navigation Technologies
    - └ TX17.2.1 Onboard Navigation Algorithms

Target Destination

Others Inside the Solar System

Images



11548-1366225047294.jpg
Project Image The Regolith Biters: A Divide-And-Conquer Architecture for Sample Return Missions *(https://techport.nasa.gov/image/102329)*